REMARKS

Claims 14-15 have been canceled without prejudice. Claims 17-22 have been added. Support for the new claims can be found in the original claim set. Claims 1-2, 4, 8 and 11-13 have been amended. No new matter has been introduced. With entry of this Amendment, claims 1-13 and 16-22 will be pending.

Claims 1-2 are rejected under 35 U.S.C. §102(b) as being anticipated by or, in the alternative, under 35 U.S.C. §103(a) as being obvious over Chinese Patent No. 1063907 ("Li"). Claims 3-16 are rejected under 35 U.S.C. §103(a) as being obvious over Li.

Applicant respectfully requests consideration and allowance of the application for the reasons outlined below.

Independent Claim 1 and Dependent Claims 2-13 and 16

Claim 1 is rejected under 35 U.S.C. §102(b) as being anticipated by or, in the alternative, under 35 U.S.C. §103(a) as being obvious over Li. Applicant had an English translation of Li prepared. A copy of that translation is attached for the Examiner's benefit. Any reference to Li below refers to the English translation.

Li discloses a method that "includes reinforcedly dissolving an alkane and a chrome metal which is deposited on the surface into a brass base ... forming an alloy coat of Cu-Cr-alkane with drip condensing effect." Abstract. The method includes: "polishing the surface of a brass work piece ... argon ionic sputtering cleaning ... ionic plating with the partial pressure of the argon gas at 0.01-0.015 mmHg and the partial pressure of alkane gas at 0.01-0.015 mmHg, which comprises ionic plating for 15-40 seconds while the work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amps and a chrome target is applied with an electrical current of 500-600 Volts and 10-15 Amps ... and ... ionic sputtering." Page 3, ¶ 4 to Page 4, ¶ 2. "The method according to the present invention utilizes the magnetic controlling sputtering and ionic plating technology, i.e. a combination of magnetic controlling sputtering technology and the ionic plating technology, which reinforcedly dissolves an alkane and a chrome metal layer which is deposited on the outer surface into a brass base, thereby forming an alloy layer of Cu-Cr-alkane. Page 4, ¶ 3. The formation of the Cu-Cr-alkane layer is demonstrated in Exemplary Embodiments 1-3. Pages 5-6.

Independent claim 1 recites "[a] process for depositing a film onto a bare or unplated zinc or zinc alloy substrate, the process comprising: directly depositing a film onto a portion of the substrate by physical vapor deposition, the film being a metal film, a ceramic film or a combination thereof, wherein the metal film includes nickel, titanium, zirconium or a combination thereof, and wherein the ceramic film includes a nitride, a carbide, an oxide or a nitroxide of nickel, titanium, zirconium, or a combination thereof."

Li neither teaches nor suggests depositing "a metal film, a ceramic film or a combination thereof, wherein the metal film includes nickel, titanium, zirconium or a combination thereof, and wherein the ceramic film includes a nitride, a carbide, an oxide or a nitroxide of nickel, titanium, zirconium, or a combination thereof." Therefore, Applicant respectfully requests reconsideration and allowance of independent claim 1.

Claims 2-13 and 16 ultimately depend from allowable independent claim 1, and therefore, are allowable. Claims 2-13 and 16 may recite additional patentable subject matter for reasons not explicitly disclosed herein. Reconsideration and allowance of claims 2-13 and 16 are respectfully requested.

Independent Claim 17 and Dependent Claims 18-22

Independent claim 17 recites "[a] process for depositing a film onto a bare or unplated zinc or zinc alloy substrate, the process comprising: directly depositing a film onto a portion of the substrate by physical vapor deposition, the film being a metal film, a ceramic film or a combination thereof, wherein the metal film includes nickel, titanium, zirconium or a combination thereof, and wherein the ceramic film includes a nitride, an oxide or a nitroxide of chromium, nickel, titanium, zirconium, or a combination thereof.

Li neither teaches nor suggests depositing "a metal film, a ceramic film or a combination thereof, wherein the metal film includes nickel, titanium, zirconium or a combination thereof, and wherein the ceramic film includes a nitride, an oxide or a nitroxide of chromium, nickel, titanium, zirconium, or a combination thereof." Therefore, Applicant respectfully requests consideration and allowance of claim 17.

Claims 18-22 depend from allowable independent claim 17, and therefore, are allowable. Claims 18-22 may recite additional patentable subject matter for reasons not explicitly disclosed herein. Consideration and allowance of claims 18-22 are respectfully requested.

CONCLUSION

In view of the foregoing, reconsideration and allowance of claims 1-13 and 16 and consideration and allowance of claims 17-22 are respectfully requested. The Examiner is strongly encouraged to contact the undersigned by telephone at the Examiner's convenience should any issues remain.

Respectfully submitted,

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Translation of CN 1063907

Abstract

The invention relates to a manufacturing method for forming a dropwise condensation metal material. The method includes reinforcedly dissolving an alkane and a chrome metal which is deposited on the surface into a brass base, such that forming an alloy coat of Cu-Cr-alkane with drip condensing effect. The ionic plating lasts 15 to 40 seconds under the partial pressure of argon gas at 0.01-0.015 mmHg and the partial pressure of alkane gas at 0.01-0.015 mm Hg, while a work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amp and the chrome target is applied with an electrical current of 500-600 Volts and 10-15 Amps. The ionic sputtering lasts 10-15 minutes with the argon partial pressure of 0.02-0.03 mmHg while the work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amp.

What is claimed is:

1. A method for manufacturing a ***dropwise condensation metal material*** [1] for water vapor or other vapor condensing, wherein the feature is:

a. polishing the surface of a brass work piece which is to be plated to a surface finish degree of □10, then cleaning the brass work piece with acetone, and then positioning the brass base into a magnetic controlling sputtering and ionic plating oven;

b. argon ionic sputtering cleaning, which comprises introducing argon gas into the oven when a ***vacuum degree*** [2] inside the oven is $4\text{-}8\times10^{-5}$ mmHg to increase the partial pressure to $6\text{-}8\times10^{-3}$ mmHg, and argon ionic sputtering the brass work piece for 5-10 minutes when the brass work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amp;

c. ionic plating with the partial pressure of the argon gas at 0.01-0.015 mmHg and the partial pressure of alkane gas at 0.01-0.015 mmHg, which comprises ionic plating for 15-40 seconds when the work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amp and a chrome target is applied with an electrical current of 500-600 Volts and 10-15 Amps; and

d. ionic sputtering for 10-15 minutes when the partial pressure of the argon gas is at 0.02-0.03 mmHg and the work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amp.

NOTES:

1. "dropwise condensation metal material" or "drip condensing metal material", I think they have similar meaning.
2. "vacuum degree" is misspelled in the original Chinese application, but it should be easy to understand what does this term mean according to the specification.

2. A method according to Claim 1 wherein the feature is that said argon ionic sputtering cleaning comprises introducing the argon gas into the oven when a vacuum degree inside the oven is 5×10^{-5} mmHg to increase the partial pressure to 7×10^{-3} mmHg, and argon ionic sputtering cleaning the brass work piece for 5 minutes while the brass work piece is applied with an electrical current of 2000 Volts and 0.1 Amp, said ionic plating comprises ionic plating for 30 seconds with the partial

pressure of the argon gas at 0.012 mmHg and the partial pressure of the alkane gas at 0.015 mmHg when the work piece is applied with an electrical current of 1500-2000 Volts and 0.1 Amp and the chrome target is applied with an electrical current of 600 Volts and 15 Amps, and said ionic sputtering comprises ionic sputtering for 10 minutes while the partial pressure of the argon gas is at 0.03 mmHg and the work piece is applied with an electrical current of 2000 Volts and 0.1 Amp.

3. A method according to Claim 1 wherein the feature is that the alkane gas is ethane gas.

A Manufacturing Method For Forming A Dropwise Condensation Metal Material

The present invention relates to a material for water vapor or other vapor condensing, and, more particularly, to a material having a metal surface having an alloy layer with low surface energy.

Nowadays, some known methods for forming dropwise condensation on a metallic surface mainly include: 1) applying an organic accelerating agent on the metallic surface (J.P. 58171466); 2) applying some inorganic substance on the metallic surface [Erb, R.A & Thelen, E. Dropwise condensation characteristics of permanent hydrophobic systems, U.S. Department of Interior, Office of saline water, R&D Report, NO. 184 (1966)]; 3) plating a polymer film on the metallic surface (J.P. 58133875); 4) plating gold, silver, chrome and other metals on the metallic surface [Finnicum, S.S. & Westwater, J.W., Int. J. Heat Mass Transfer, Vol. 32, NO. 8, PP. 1541-1549 (1989)]; 5) use tantalum, zirconium and their alloys as the dropwise condensation surface (U.S.-2248909). Although above methods form water vapor dropwise condensation on the metallic surface, they all have some drawbacks. Such as for example, applying organic or inorganic accelerating agent on the metallic surface contaminates the cooling fluid, shortens the service life, and corrodes the metallic surface; polymer film plating has a considerably big additional thermal resistance; electroplating noble metals such as gold or silver increases the manufacture cost; chrome is not noble metal, but dropwise condensation only remains a relatively short time period on the chrome plated surface, generally hundreds of hours, at most thousands of hours; and tantalum and zirconium are relatively expensive, and have a relatively unsatisfactory heat conduction performance. Due to above reasons, dropwise condensation has not been industrialized. Moreover, a few amount of ammonia, generally with a concentration of 0.7-1.0 mg/l, is commonly introduced into the boilers which are used to produce water vapor in the industrial manufacture, in order to avoid corroding in the condensate system of the feed water system. It is proved from the experiments that, in such situation, dropwise condensation can not been formed on the electroplating or ionic chrome plating metallic surface, or on the tantalum/zirconium surface, and the dropwise condensation on the ionic ethane plating surface only lasts for few hours before changing into film condensation.

In order to overcoming the drawback of the above prior arts, there is an object of the present invention to provide a method for producing an industrialized metal material which has long-term dropwise condensing effect for water vapor and water vapor containing a few amount of ammonia.

The object of the present invention can be realized by the below method: a method for manufacturing a dropwise condensation metal material condensed by water vapor or other vapor, wherein the feature is:

a. polishing the surface of a brass work piece which is to be plated to a surface finish degree of □10, then cleaning the brass work piece with acetone, and then positioning the brass base into a magnetic controlling sputtering and ionic plating oven;

b. argon ionic sputtering cleaning, which comprises introducing argon gas into the oven when a vacuum degree inside the oven is $4\text{-}8\times10^{-5}$ mmHg to increase the partial pressure to $6\text{-}8\times10^{-3}$ mmHg, and argon ionic sputtering the brass work piece for 5-10 minutes while the brass work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amps;

c. ionic plating with the partial pressure of the argon gas at 0.01-0.015 mmHg and the partial pressure of alkane gas at 0.01-0.015 mmHg, which comprises ionic plating for 15-40 seconds while the work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amps and a chrome target is applied with an electrical current of 500-600 Volts and 10-15 Amps; and

d. ionic sputtering for 10-15 minutes while the partial pressure of the argon gas is at 0.02-0.03 mmHg and the work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amps.

The method according to the present invention utilizes the magnetic controlling sputtering and ionic plating technology, i.e. a combination of magnetic controlling sputtering technology and the ionic plating technology, which reinforcedly dissolves an alkane and a chrome metal layer which is deposited on the outer surface into a brass base, thereby forming an alloy layer of Cu-Cr-alkane. The alloy layer has a drip condensing effect.

The method according to the present invention is briefly described as below:

Proving a work piece to be plated → performing a polishing pretreatment → argon ionic sputtering cleaning → ionic plating → ionic sputtering →forming an alloy layer of Cu-Cr-alkane.

The manufacturing method according to the present invention includes firstly performing a pretreatment on the brass work piece to be plated. The surface of the brass base which is to be plated is polished to reach a surface finish degree of □10, and then is cleaned by acetone. When the surface of the brass base is dry, the brass work piece is positioned into a magnetic force controlling sputtering and ionic plating oven. The plating process includes argon ionic sputtering cleaning, ionic plating, and ionic sputtering. The ionic sputtering cleaning process is preformed in the magnetic force controlling sputtering and ionic plating oven. The interior of the oven is required to reach a predetermined vacuum degree. If the vacuum degree is too low and leads to the mixture of argon gas with other gas, the impurity of the working gas will decrease the cleaning result, such that a higher vacuum degree inside the oven is preferred. But excessively high vacuum degree inside the oven results in a higher requirement for the manufacturing technology and a higher manufacture cost. As such, an appropriate vacuum degree, such as $4\text{-}8\times10^{-5}$ mmHg can suffice the manufacture requirement. The argon gas is introduced into the oven with the predetermined vacuum degree, such that the partial pressure is increased to $6\text{-}8\times10^{-3}$ mmHg, and the magnetic force controlling sputtering and ionic plating oven may ***start arc***[3] in such situation. The work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amp in such situation for performing the argon ionic sputtering cleaning, thereby realizing the cleaning requirement. The time period for performing such argon ionic sputtering cleaning depends on the clean level of the surface of the brass work piece, generally a 5-10 minutes cleaning step can reach the cleaning requirement for the next plating step. The ionic plating step includes positioning the work piece in the oven with the partial pressure of the argon gas at 0.01-0.015 mmHg and the partial pressure of alkane gas at 0.01-0.015 mmHg. The alkane gas includes methane, ethane, and propane etc., wherein ethane is preferred since ethane has a good absorbability. The work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amp, and a chrome target is applied with an electrical current of 500-600 Volts and 10-15 Amps at the same time for performing the ionic plating step. When the negative bias, also referred to as the applied voltage on the work piece, is too low, the coating layer doesn't have a good fastness with the metal base, and it is relatively hard to form an alloy layer. When the negative bias is between 1500-2000 Volts, it will suffice to form the alloy layer. A long

plating time period results in an excessively thick chrome layer deposited on the base, which is relatively hard to form a chrome film layer; and a short plating time period results in only a little chrome deposited on the base, and the alloy layer on the base is too thin to meet the practical requirement, a thickness of 5000-10000 Å (Å= 1×10^{-10} m). The plating time varies according to different types of ionic plating machine, and a general plating time is between 15-40 seconds. The ionic sputtering step reinforcedly dissolves the chrome deposited on the surface and alkane (which has already partially formed the alloy layer) into the brass base by ionic sputtering the working gas. The ionic sputtering is preformed for 10-15 minutes, while the partial pressure of the argon gas is at 0.02-0.03 mmHg and the work piece is applied with an electrical current of 1500-2000 Volts and 0.1-0.3 Amp. As such, an alloy layer of Cu-Cr-alkane with a thickness of 5000-10000 Å is obtained on the brass basis, and the layer has a silvery white metallic appearance.

NOTE 3: "start arc" also be called as arc starting.

The alloy layer manufactured by the method according the present invention has no corroding or pollution drawback, has a relatively small thermal resistance and a good thermal conductivity, and realizes a long-term dropwise condensing effect for water vapor and water vapor containing a few amount of ammonia. The alloy layer doubles the heat exchanging efficiency, and reduces the size of the heat exchanger having the same working load by half, which reduces the raw material needed for the manufacture and the area for installment. The alloy layer is proved by the experiments that has a service life of more than two years.

Exemplary Embodiment 1

Polishing the surface of a Φ $16\times1\times3200H_{53}$ brass tube to a surface finish degree of □10, then cleaning the tube with acetone, and then positioning the brass tube into a magnetic controlling sputtering and ionic plating oven. The oven is elongated and cylindrical in shape, and has cathode inner surface surrounding an inner opening therein. An argon gas is introduced into the oven when a vacuum degree inside the oven is at 5×10^{-5} mmHg to increase the partial pressure to 7×10^{-3} mmHg. An argon ionic sputtering cleaning step is performed for 5 minutes when the brass tube is applied with an electrical current of 2000 Volts and 0.3 Amp. An ionic plating step is performed for 30 seconds when the partial pressure of the argon gas is at 0.012 mmHg, the partial pressure of ethane gas is at 0.015 mmHg, the brass tube is applied with an electrical current of 2000 Volts and 0.1 Amp, and a chrome target is applied with an electrical current of 600 Volts and 15 Amps. An ionic sputtering step is then performed for 10 minutes when the partial pressure of the argon gas is 0.03 mmHg and the brass tube is applied with an electrical current of 2000 Volts and 0.1 Amp. As such, a Cu-Cr-alkane alloy layer having a silvery white metallic appearance is obtained on the brass tube, and the layer has a thickness of 8000 Å.

Exemplary Embodiment 2

A Φ $16\times1\times200$ brass tube is pretreated as the exemplary embodiment 1. An argon gas is then introduced into a coaxial magnetic controlling sputtering and ionic plating oven when a vacuum degree inside the oven is at 7×10^{-5} mmHg to increase the partial pressure to 8×10^{-3} mmHg. An argon ionic sputtering cleaning step is performed for 10 minutes when the brass tube is applied with an electrical current of 1500 Volts and 0.3 Amp. An ionic plating step is performed for 15 seconds

when the partial pressure of the argon gas is 0.015 mmHg, the partial pressure of methane gas is 0.01 mmHg, the brass tube is applied with an electrical current of 1500 Volts and 0.3 Amp, and a chrome target is applied with an electrical current of 500 Volts and 10 Amps. An ionic sputtering step is then performed for 15 minutes when the partial pressure of the argon gas is at 0.02 mmHg and the brass tube is applied with an electrical current of 1500 Volts and 0.3 Amp. As such, a Cu-Cr-alkane alloy layer having a silvery white metallic appearance is obtained on the outer surface of the brass tube, and the layer has a thickness of 5000 Å.

[Remarks: The brass tube has a specification of Φ 16×1×200 which is different from the specification of the brass tube in Embodiment 1.*]*

Exemplary Embodiment 3

A Φ 16×1×200 brass tube is pretreated as the exemplary embodiment 1. An argon gas is then introduced into a coaxial magnetic controlling sputtering and ionic plating oven when a vacuum degree inside the oven is 4×10^{-5} mmHg to increase the partial pressure to 6×10^{-3} mmHg. An argon ionic sputtering cleaning step is performed for 7 minutes when the brass tube is applied with an electrical current of 1800 Volts and 0.2 Amp. An ionic plating step is performed for 40 seconds when the partial pressure of the argon gas is 0.01 mmHg, the partial pressure of ethane gas is 0.015 mmHg, the brass tube is applied with an electrical current of 1800 Volts and 0.2 Amp, and a chrome target is applied with an electrical current of 550 Volts and 12 Amps. An ionic sputtering step is then performed for 12 minutes when the partial pressure of the argon gas is 0.025 mmHg and the brass tube is applied with an electrical current of 1800 Volts and 0.2 Amp. As such, a Cu-Cr-alkane alloy layer having a silvery white metallic appearance is obtained on the outer surface of the brass tube, and the layer has a thickness of 10000 Å.